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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/887,199	06/21/2001	Ivo Raaijmakers	ASMMC.005AUS	7254

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EXAMINER

MAI, ANH D

ART UNIT PAPER NUMBER

2814

DATE MAILED: 08/12/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Applicati n No.

09/887,199

Applicant(s)

RAAIJMAKERS ET AL.

Examiner

Anh D. Mai

Art Unit

2814

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 27 May 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-19 is/are pending in the application.
- 4a) Of the above claim(s) 2-5 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1 and 6-19 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Status of the Claims

1. Amendment filed May 27, 2003 has been entered as Paper No. 11. Claim 1 has been amended. Claims 1-19 are pending. Claims 2-5 have been withdrawn.

Specification

2. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: METHOD OF FABRICATING TRENCH ISOLATION STRUCTURES FOR INTEGRATED CIRCUIT USING ATOMIC LAYER DEPOSITION.

Claim Objections

3. Claims 13 and 14 are objected to because of the following informalities:

Claim 13, lines 1-2 recites: "wherein filling the trench comprises depositing between about 23% and 37% aluminum oxide by weight in silicon oxide".

However, the specification discloses: "This correspond to an Al_2O_3 concentration between about 23 wt % and 37 wt % in the mixture". (page 19, lines 14-15).

Note that the mixture is not silicon oxide but rather alumina (Al_2O_3) and silica (SiO_2).

The similar is also applied to claim 14.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1 and 6-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gates et al., (U.S. Patent No. 6,203,613) of record and M. Ritala et al., *Perfectly Conformal TiN and Al₂O₃ Films Deposited by Atomic Layer Deposition*, of record (IDS, Paper No. 4).

Gates teaches a method of fabricating trench isolation structures between integrated electrical devices in a semiconductor substrate as claimed including:

placing a semiconductor substrate in a reaction chamber, the semiconductor substrate comprising trenches; and

filling the trenches with insulating material (metal-containing film) by atomic layer deposition (ALD), comprising a plurality of primary cycle, each primary cycle comprising, in sequence:

introducing a first vapor-phase reactant (1st metal precursor) to the substrate, thereby forming no more than about one monolayer of a first reactant species conforming at least to surface of the trenches;

removing (inert purge) excess first vapor-phase reactant and byproduct from the reaction chamber;

introducing a second vapor-phase reactant (co-reactant) to the substrate, thereby reacting with the first reactant species conforming at least to the surfaces of the trenches; and

removing (inert purge) excess second vapor-phase reactant and by product from the reaction chamber. (See particularly col. 6, lines 22-33).

Thus, Gates is shown to teach all the features of the claim with the exception of explicitly disclosing that the trench is completely filled.

However, Ritala teaches that trenches formed in a semiconductor substrate can be completely filled with insulating material (Al_2O_3) using ALD process. (See Figs. 1, particularly page 7, first paragraph).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to completely fill the trenches formed in the semiconductor substrate of Gates as taught by Ritala because uniformity and conformality are inherent result of ALD, thus, keyhole formation is avoided. (See Ritala, page 7).

With respect to the term “thereby forming no more than about one monolayer of a first reactant species conforming at least to surface of the trenches”, the ALD results in one layer per cycle.

With respect to the term “thereby reacting with the first reactant species conforming at least to the surfaces of the trenches”, since the second vapor-phase reactant of Gate is co-reactant, the term, thereby reacting, is met.

With respect to claim 6, the ALD of Gate further including a plurality of secondary cycles, each secondary cycle comprising, in sequence:

introducing a third vapor-phase reactant (2nd precursor) to the substrate, thereby forming no more than about one monolayer of a third reactant species conforming at least to surfaces of the trenches, the third reactant species being different from the first reactant species;

removing (inert purge) excess third vapor-phase reactant and byproduct from the reaction chamber,

introducing a fourth vapor-phase reactant (co-reactant) to the substrate, thereby reacting the third reactant species conforming at least to the surface of the trenches; and

removing (inert purge) excess fourth vapor-phase reactant and byproduct from the reaction chamber. (See col. 6, lines 25-33).

With respect to claim 7, although Gates does not disclose the specific reactants as claimed, however, Gates clearly discloses that, metal-containing precursor having the formula $M(NO_3)_x$, wherein M is a metal selected from the group including Si and Al and co-reactant gas includes oxidizing agent (col. 4, lines 40-51).

With respect to claim 8, the metal source gas of Gates also includes metal-alkyl compounds and the oxidant source gas includes water, thus, the limitation of the claim is met.

With respect to claim 9, the filling of the trench of Gates in view of Ritala consists of mixing the primary cycle and secondary cycles and the mixing ratio (alternate 1:1) is within the claimed ratio between about 20:1 and 1:10.

With respect to claim 10, the primary cycles of Gates deposit a first oxide species and the secondary cycle deposit a second oxide species. (See col. 9, lines 5-14).

With respect to claim 11, the first oxide species of Gates is silicon oxide and the second oxide species is a metal oxide. (See Example 4).

With respect to claim 12, the second oxide species of Gates also includes aluminum oxide. (See col. 4, lines 40-51).

With respect to claims 13 and 14, the method of Gates includes any combination of multiplayer metal oxide film.

Note that the specification contains no disclosure of either the *critical nature of the claimed composition* (23% + 37%, claim 13 and 26% +34%, claim 14) *of any unexpected results arising therefrom*. Where patentability is aid to based upon particular chosen dimension or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Since ALD process can form monolayer-by-monolayer, therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the multiplayer metal oxide of Gates, in view of Ritala, in any combination to achieve a superior isolation.

With respect to claim 15, at least a portion of the first and second oxide species of Gates inherently combine to form a separate phase appears to be in equilibrium with a portion of the first oxide.

With respect to claim 16, since the multiple ALD layer also includes silicon oxide and aluminum oxide as contemplated by Gates, thus, the separate phase of Gates also comprises mullite. Mullite is a mixture described as: $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$. Another word, any five layer of metal oxide including three layer of Al_2O_3 sandwiched by two layer of SiO_2 .

With respect to claim 17, similar to claims 13 and 14 above, the method of Gates includes any combination of multiplayer metal oxide film.

Note that the specification contains no disclosure of either the *critical nature of the claimed composition* (25% mullite and 50% mullite by weight) *of any unexpected results arising therefrom*. Where patentability is aid to based upon particular chosen dimension or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Since ALD process can form monolayer-by-monolayer, therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the multiplayer metal oxide of Gates, in view of Ritala, in any combination to achieve a superior isolation.

With respect to claim 18, since silica and alumina have been contemplated by Gates for the metal-oxide insulator (see col. 4, line 40-51), these metal-oxide can be alternatively deposited (e.g., at least 1:1). This ratio is within the disclosed ratio (20:1 to 1:10) to achieve a coefficient

of thermal expansion (CTE) within about 20% of silicon's CTE. (See specification page 19, line 23-25).

With respect to claim 19, Gates does not explicitly disclosing mixing of the primary cycle and secondary cycle to achieve a coefficient of thermal expansion (CTE) within about 10% of silicon's CTE.

However, the specification contains no disclosure of either the *critical nature of the claimed coefficient of thermal expansion within 10% of the semiconductor substrate's CTE* of any unexpected results arising therefrom. Where patentability is aid to based upon particular chosen CTE or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to fill the trenches such that CTE of the insulating material should closely match that of the semiconductor substrate to prevent a large thermal stress on the semiconductor substrate which is a main cause of failure, such as cracking.

Response to Arguments

5. Applicant's arguments with respect to all claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anh D. Mai whose telephone number is (703) 305-0575. The examiner can normally be reached on 8:30AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7722 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.



A.M
August 6, 2003